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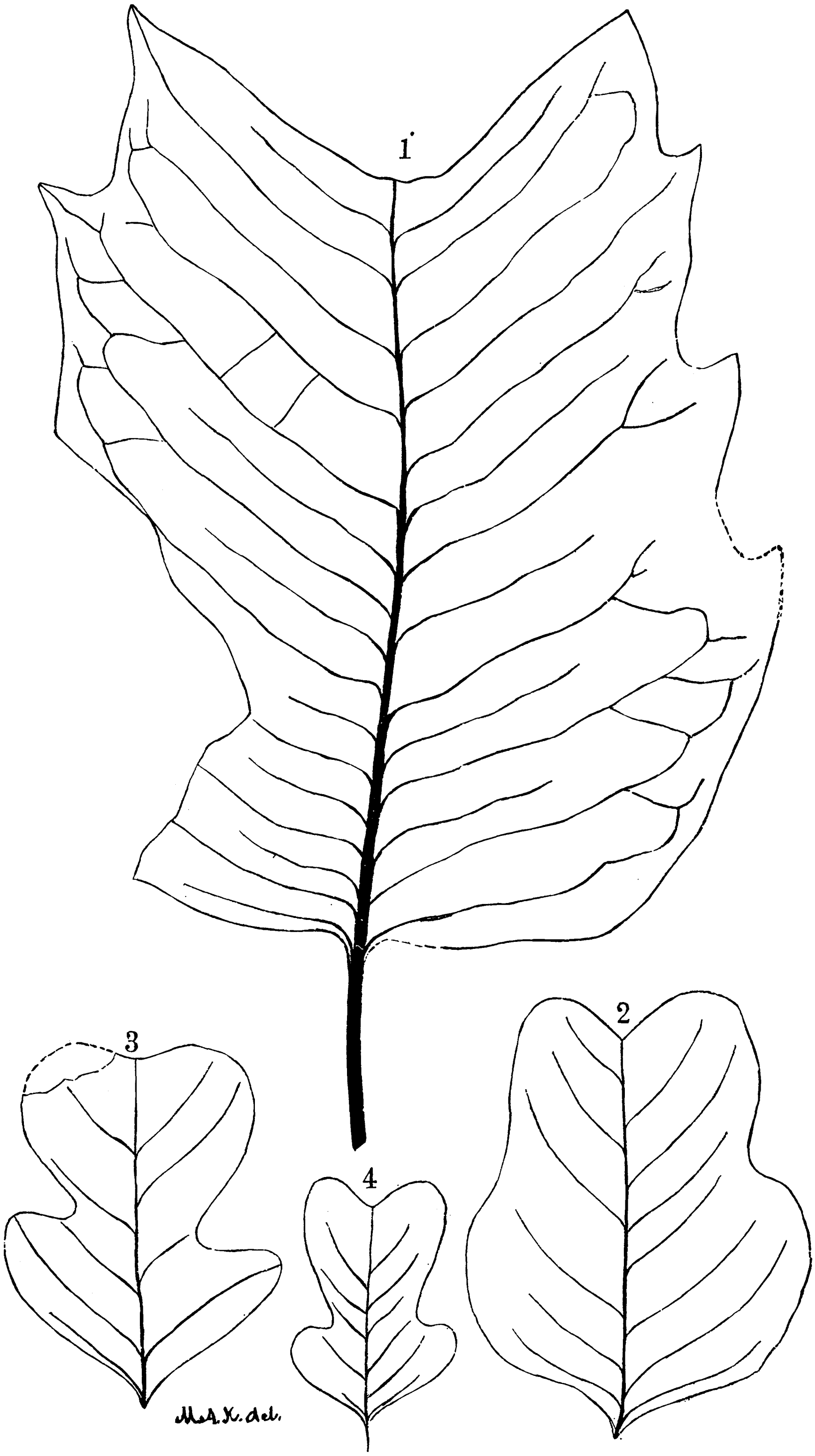
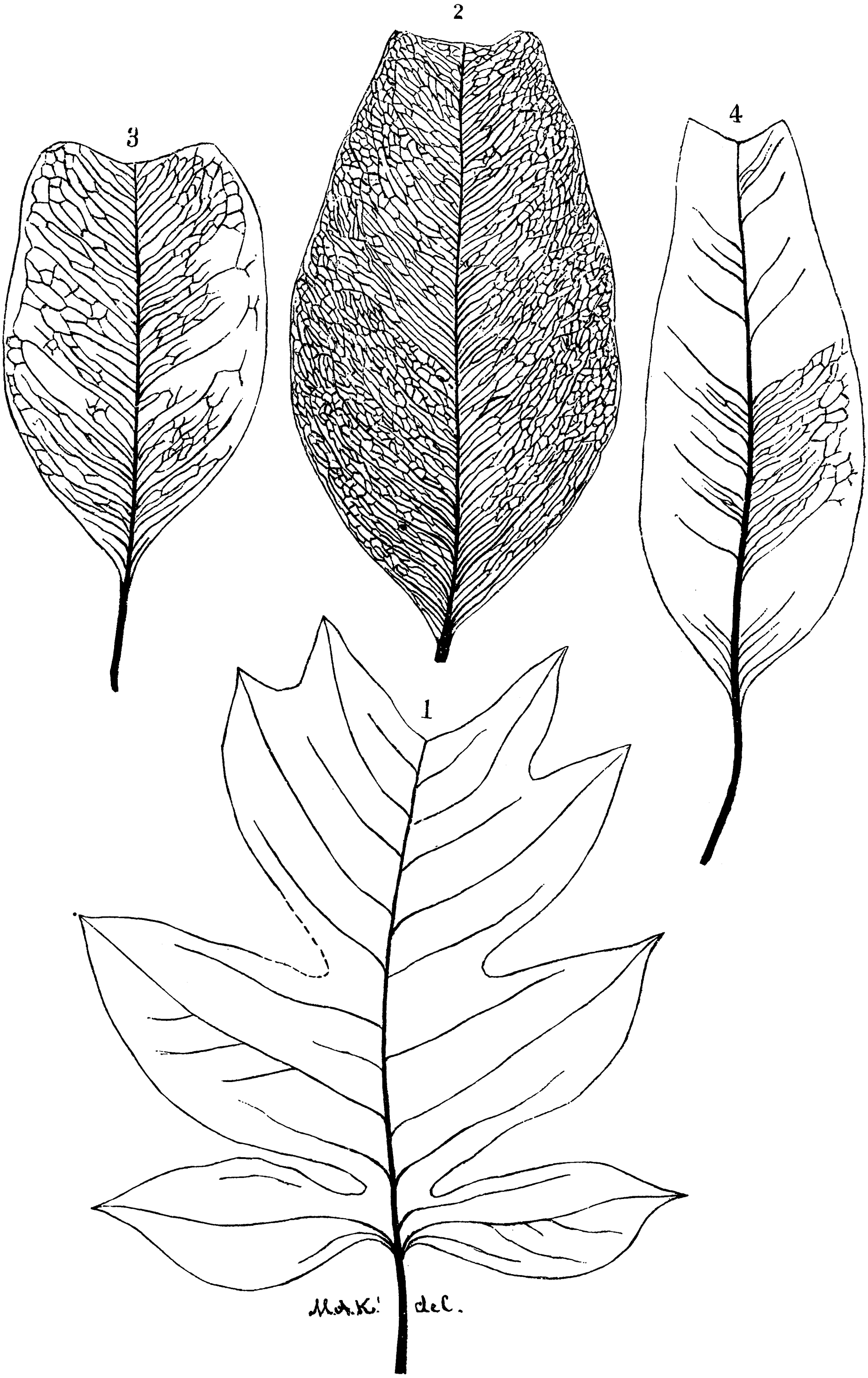


Cretaceous Liriodendra.



Cretaceous Liriodendra.

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The Ancestors of the Tulip-Tree.

By J. S. Newberry.

Plates LXI and LXII.

The genus *Liriodendron*, as all botanists know, is represented in the present flora by a single species, "the Tulip-tree," which is confined to Eastern America, but grows over all the area lying between the Lakes and the Gulf, the Mississippi and the Atlantic. It is a magnificent tree, on the whole the finest in our forests. Its cylindrical trunk, sometimes ten feet in diameter, carries it beyond all its associates in size, while the beauty of its glossy lyre-shaped leaves and tulip-like flowers are only surpassed by the flowers and foliage of its first cousin, *Magnolia grandiflora*. That a plant so splendid should stand quite alone in the vegetation of the present day excited the wonder of the earlier botanists, but the Sassafras, the Sweet-gum and the great Sequoias of the far West afford similar examples of isolation, and the latter are still more striking illustrations of solitary grandeur.

Before the study of fossil plants threw its light upon the history of our living flora such cases admitted of no satisfactory explanation, but we now know that all the trees enumerated above with our Magnolias, Button-ball and deciduous Cypress, are relics of the golden age of North America vegetation; of a time when a genial climate prevailed all the way to the Arctic Sea, and when a well-watered and fertile soil supported forests in which our now lonely giants lived surrounded by brothers, cousins and more distant relatives as gigantic as themselves, and all combined to form the grandest forest-growth the world has ever seen. But the glorious summer which continued perhaps a million of years, and created or fostered all the noblest forms of forest life that have come down to us, and many perhaps nobler, that have perished, was followed by a winter of corresponding severity and duration—the Ice Period—in which snows and glaciers spread from Greenland and Alaska southward until two-thirds of the continent was under snow and ice. All the region north of New York and Cincinnati was then changed from a paradise to a howling wilderness, where not a trace remained of the luxuriant vegetation that before covered the surface, or of the varied fauna that was associated with it, except where leaves, trunks and bones, relics of earlier generations, were buried in rock or soil too deep to be reached by the grinding glacier or the burrowing torrent. These relics we have disinterred on Greenland, Disco Island, on the McKenzie and in Alaska, as well as at many places further south, in the country bordering the Columbia, the Missouri, in New Jersey and Virginia. Seven quarto volumes filled with descriptions and plates of fossil plants constitute the contribution that Prof. Oswald Heer has made in his "Flora Arctica" to our knowledge of the vegetation that covered the circum-polar lands before the Ice Age, and an equal mass of material has been gathered by Lesquereux, Ward, Fontaine and the writer, as a preparation for the work of illustrating the wonderfully rich Cretaceous and Tertiary flora of North America. Although but a beginning has yet been made, already the remains of at least a thousand distinct species of arborescent plants have been brought to light. The botanical relations of many, perhaps most of these, are yet to be accurately determined, but the general character of the vegetation which covered our continent in the later geological ages has certainly been ascertained, and much light has been thrown on the derivation and history of our present flora.

With the facts before us, we are fully warranted in making the statements, that our angiosperm flora began its existence on this continent in middle Cretaceous times, that even then its present aspects were distinctly developed, and subsequent changes have been rather of degree than of kind. In the banishment of our Tertiary flora from the great area it once occupied, and its restriction to the narrow space at the South into which it was forced, many of its finest elements were destroyed; and when, with an amelioration of climate, the exiles returned to that portion of their former home again opened to them, they came as a handful representing a host, perhaps as solitary species, remnants of generic groups that mostly perished by the way.

Among these survivors the Sequoias stand first in magnitude and interest, and their story has been admirably told by Dr. Gray in his "Sequoia and its History." The Liriodendron, the Magnolias, the Liquidambar, the Cypress, the Sassafras and Platanus, will also, I hope, have their biographers, and to aid in the task of one of these I now give some of the facts which have come to my knowledge in regard to the history of our lyre-leaved Tulip-tree.

Three species of *Liriodendron* are indicated by leaves found in the Amboy clays—Middle Cretaceous—of New Jersey, and others have been obtained from the Dakota group in the West, and from the Upper Cretaceous strata of Greenland. Though differing considerably among themselves in size and form, all these have the deep sinus of the upper extremity, so characteristic of the genus, and the nervation is also essentially the same. Hence, we must conclude that the genus *Liriodendron* now represented by a single species was in the Cretaceous age much more largely developed, having many species, and those scattered throughout many lands. In the Tertiary age the genus continued to exist, but the species seem to have been reduced to one, which is hardly to be distinguished from that now living. In many parts of Europe leaves of the Tulip-tree have been found, and it extended as far south as Italy. Its presence there was first made known by Unger in his Synopsis, p. 232, and in his *Genera et Species*, p, 443, where he describes it under the name of *Liriodendron Procaccinii.* Later it was mentioned by Massalongo (Flora Senogalliensis, p. 311) and Heer (Urwelt der Schweiz, p. 331) and it is enumerated and figured among the fossil plants of Iceland by Heer in his Flora Arctica, Vol. I., p. 151, taf. XXVI., fig. 7 b; taf. XXVII., fig. 5–8; from the Tertiary of Greenland, Vol. VII., p. 121, taf. LXXXIII. Leaves of similar form are described and figured in Heer's Flora Tertiaria Helvetiæ, Vol. III., p. 29, tab. CVIII., fig. 6, with the name of *Liriodendron Helveticum,* Fisch.; also Ettinghausen in his Flora v. Bilin, p. 9, tab. XLI., fig. 10, describes a fragment which he names *L. Haueri.* All these are, however, so much like the living species that it is impossible to distinguish them, and they should probably be united with it. We here have a striking illustration of the wide distribution of a species which has retained its characters both of fruit and leaf quite unchanged through long migrations and an enormous lapse of time.

In Europe the Tulip-tree, like many of its American associates, seems to have been destroyed by the cold of the Ice Period, the Mediterranean cutting off its retreat, but in America it migrated southward over the southern extension of the continent and returned northward again with the amelioration of the climate.

Of the species of *Liriodendron* found in the Dakota group of Kansas, the leaves of one (*L. Primævum*, Newb., Later Extinct Flora of North America, p. 12), are much like those of the living species, but are considerably smaller. Another species (*L. Meekii*, Heer), has small fiddle shaped leaves (Plate LXI., fig. 3–4). Prof. Heer considers this identical with *L. primævum*, but the form is quite different and no connecting links have been found. From the Amboy clays we have obtained one leaf which apparently represents *L. Meekii*; it is typically fiddle-shaped, though larger then the Dakota leaves.

Prof. Heer also unites with *L. Meekii* some ovate emarginate leaves from the Dakota and Greenland strata, to which he formerly gave the names *Phyllites obcordatus* and *Leguminosites Marcouanus*, but it is by no means certain that they were borne by the same tree that carried the leaves called *Liriodendron Meekii*. Indeed the probabilities are against it since no intermediate forms have been found, and none of the panduriform leaves of *L. Meekii* have been obtained from Greenland, where obovate, entire or emarginate leaves similar to those given the above names do occur, and also many of the emarginate, oblong-ovoid or lanceolate leaves, which I have called *Liriodendron simplex*.

Several additional species of *Liriodendron* are enumerated by Mr. Lesquereux among the fossil plants of the Dakota group, viz.: *L. giganteum*, Lesqx.; *L. intermedium*, Lesqx., (Cret. Flora, p. 93, Pl. XX., fig. 5; Pl. XXII., fig. 2); *L. acuminatum*, Lesqx.; *L. cruciforme*, Lesqx.; *L. semi-alatum*, Lesqx.; *L. pin-*

natifidum, Lesqx. (Bull. Mus. Comp. Zoöl., Vol. VII., No. 6, p. 227.) As only the first two are figured, and that from fragments, and the others very briefly described, I am unable to make any satisfactory use of this important material in tracing the life-history of the genus.

It is a remarkable fact that among all the great collections of Laramie and Eocene plants made on the Upper Missouri, in Oregon, Washington, Wyoming and Colorado, and studied by Lesquereux, Ward and the writer, not a single leaf of *Liriodendron* has yet been identified.

I append figures and descriptions of three new species of Tulip-tree recently obtained from the Amboy clays of Woodbridge, New Jersey.

LIRIODENDRON OBLONGIFOLIUM, n. sp.

PL. LXI., FIG. 1.

Leaves 6 to 8 inches in length, by 4 to 5 inches in breadth, oblong in outline, long-petioled; base rounded, square or slightly cordate; summit deeply emarginate, sides bearing three or more obtuse or acute points, separated by shallow sinuses; nervation distinct, moderately strong, midrib straight, terminating in the bottom of the sinus of the upper extremity, lateral nerves nearly straight, parallel, forming two series, the stronger ones separated by intervals from a quarter to half an inch broad, branching and inosculating at their extremities, and forming a series of loops near the margin; between these are shorter and more delicate nerve-branches, which are usually simple and equally divide the interspaces.

Unfortunately but few of these leaves have been found, and none of them are quite perfect. Together they are, however, sufficient to determine the general form and nervation. Their resemblance to the leaves of the living species, *L. tulipifera,* is striking, but the form is more oblong. In the living species the lobes of the margin are quite variable; generally the basal pair are much developed, and above these a deep sinus on each side leads up to the terminal points. Not unfrequently, however, we find two, and sometimes three, points on a side, and a much nearer approach to the form of the leaves before us. The leaves of the living species are, however, always shorter, and relatively broader, yet the resemblance on the whole is so close that it is impossible to avoid the conclusion that we have in these Cretaceous leaves relics of the progenitor of the living species with all the more important characters of form and nervation already distinctly specialized.

LIRIODENDRON QUERCIFOLIUM, n. sp.

PL LXII., FIG. 1.

Leaves large, 6 inches long by 4 broad, long petioled, base horizontal or slightly cordate, summit deeply emarginate, sides bearing each three or four pointed, sometimes spatulate lobes, separated by narrow sinuses which reach nearly to the midrib; nervation regular, midrib straight or curved, terminating at the bottom of the sinus of the summit, strong side branches traversing each lobe and terminating in the point, between these more delicate, generally simple, branchlets.

The general form of these leaves is considerably like that of some of the oaks, *Quercus alba*, *Q. nigra*, etc.; a character which has suggested the name. The strong terminal emargination, and the nervation suffice, however, at once to separate them from *Quercus*, and bring them into *Liriodendron*. As will be seen by the figures now given there is considerable diversity in these leaves, some having broader lobes and shallower sinuses, approaching the form of those of *L. oblongifolium*, with which they are associated in the Amboy clays. As a whole they show a variation from the leaves of the living species in an opposite direction from those of *L. oblongifolium*, the latter being more simple in outline, oblong in form, with small points or lobes on the sides, whereas these are much more deeply lobed.

LIRIODENDRON SIMPLEX, n. sp.

PL. LXII., FIGS. 2, 3, 4.

Leaves 3 to 4 inches in length, long-petioled, ovate-lanceolate in outline, from 1 inch to 2 inches in width at the broadest part; summit emarginate, wedge-shaped; nervation fine, but distinct, midrib strong, terminating abruptly in the sinus of the summit; lateral branches forming two sets, the first and larger being separated by intervals of about one quarter of an inch, branching near their extremities, and anastomosing to form a coarse net-work along the border; the spaces between these divided unequally by one or several smaller, shorter, and generally simple nerve-branches which run parallel with the large ones, sometimes connecting with the exterior net-work; all the spaces between the lateral nerves occupied by a relatively coarse reticulation.

Although so different from the leaves described under the names of *L. oblongifolium* and *L. quercifolium*, these have in common with them the peculiar angular emargination so characteristic of the genus, and essentially the same nervation. The more elongate and lanceolate form represented on Plate LXII., figures 3, 4, occurs in considerable numbers, and may perhaps represent a distinct species, but others are broader and more ovate, like those represented in Plate LXII., figure 2.

Taken by themselves, these two forms would be regarded as specifically different, but there are connecting links between them, and we must regard the several shapes as showing simply the variation of foliage so common in other trees. Prof. Heer in his Flora Arctica, Vol. VI., Plate XXII., has represented a number of leaves which apparently belong to the same species with those now under consideration. All these he regards as varieties of *L. Meekii*, first described by him from the Dakota sandstones, but it seems to me that they do not represent either of the two forms from the Dakota group, *neither of which have yet been found in Greenland.* Hence, until more material shall show the simple, ovate or lanceolate forms to be connected by insensible gradations with others, I must regard them as specifically distinct.

EXPLANATION OF FIGURES.

Plate LXI., Fig. 1.—*Liriodendron oblongifolium*, N., Amboy Clays, New Jersey.

Fig. 2.—*Liriodendron primævum*, N., Dakota Group, Nebraska.

Figs. 3. 4.—*Liriodendron Meekii*, Heer, Dakota Group, Nebraska.

Plate LXII., Fig. 1.—*Liriodendron quercifolium*, N., Amboy Clays, New Jersey.

Figs. 2, 3, 4.—*Liriodendron simplex*, N., (*L. Meekii*, Heer in part, Atane, Greenland) Amboy Clays, New Jersey and Long Island.